

METAL OXIDE-CONTAINING DISPERSION AND METHOD OF PREPARING THE SAME

5 BACKGROUND OF THE INVENTION

Field of the Invention

The present invention is generally directed toward metal oxide-containing dispersions and methods of preparing the same. Metal oxide-containing dispersions according to the present invention comprise respective quantities of a surfactant, a metal oxide, and a carrier (preferably
10 a liquid carrier, and more preferably a fuel-improver additive). Preferably, the dispersions exhibit extended stability in that the metal oxide material remains suspended in the dispersion for at least about one month. Methods according to the invention generally comprise providing a quantity of metal oxide particles and dispersing the particles in a carrier with the aid of a surfactant. Depending upon the particular metal oxide particles employed as a starting material,
15 additional processing steps may be necessary to achieve a desired particle size suitable for being dispersed.

Description of the Prior Art

Fuel improver additives are materials which are added to various fuels such as gasoline,
20 diesel, and kerosene, in order to impart a beneficial property to the fuel. For example, fuel additives can be used to preserve or stabilize fuels for long periods of storage, clean engine components as the fuel is being combusted, dissolve engine deposits, control rust, inhibit friction, reduce emissions, increase fuel economy, reduce engine knock, and remove water which has become dispersed in the fuel as a result of condensation in a storage tank.

25 Fuel additives containing metal oxide materials have been found to be particularly useful in preventing or suppressing the ability of corrosive impurities found in low-grade fuels to damage engine and turbine components. Also, metal oxides assist in reducing pollutants in emissions. Two particular impurities include vanadium and sodium. Combustion of vanadium-containing fuels can produce highly corrosive vanadium oxide deposits which can foul an engine
30 or turbine in a relatively short amount of time. During combustion, sodium can react with sulfur present in the fuel to form a sulfate which is then deposited in engine or turbine parts. Certain

metal oxides, MgO in particular, have proven effective in limiting the corrosive effects of vanadium and sodium by-products.

A common problem with fuel additives can be the settling out of various components during storage of the additive, or fuel into which the additive is mixed. In the past, fuel additives containing a metal oxide, particularly MgO, were basically slurries in which the metal oxide would settle out when stored for even short periods. This settling required that these additives be intermittently stirred and often required additional handling equipment and manpower. In addition, the settled metal oxide could be damaging to pumps and nozzles through which the additive or additive-containing fuel was passed.

U.S. Patent No. 4,229,309 discloses a method of producing a magnesium-containing dispersion by reacting $\text{Mg}(\text{OH})_2$ in a non-volatile process fluid containing a dispersant. The reaction proceeds by heating the mixture to a high temperature (at least about 250°C) in order to dehydrate the $\text{Mg}(\text{OH})_2$ and thereby form MgO. The '309 patent itself describes this process as "an almost explosive" reaction in which the $\text{Mg}(\text{OH})_2$ is disintegrated into minute particles of MgO. Therefore, as one of skill in the art can appreciate, when performing reactions with hydrocarbon materials under high temperatures, basic safety considerations dictate that the process be closely monitored and controlled. In addition to potential safety issues, the process of the '309 patent involves the addition of significant amounts of energy to the reaction mixture thereby increasing the costs of performing the process.

Consequently, there exists a need in the art for a process of producing a stable metal oxide-containing dispersion which may be carried out at or near ambient conditions.

SUMMARY OF THE INVENTION

The present invention overcomes the above problems and provides a stable metal oxide-containing dispersion and method of producing the same. Generally, methods according to the invention generally comprise a means for providing a quantity of finely divided metal oxide particles, preferably particles having an average crystallite size of less than about 20 nm and a per unit weight surface area of at least about $75 \text{ m}^2/\text{g}$, and more preferably at least about $150 \text{ m}^2/\text{g}$. The finely divided particles are then mixed with respective quantities of a surfactant and a carrier for a sufficient time to suspend the metal oxide particles in the dispersion. A process according to the present invention preferably produces a dispersion wherein the metal oxide

particles remain suspended for at least about one month, and more preferably at least about 3 months. Preferably, methods of the invention are suitable for performance at or near ambient conditions.

In a preferred embodiment of the invention, the metal oxide particles are initially mixed with a quantity of carrier to form a slurry. Preferably, the slurry comprises from about 0.1-50% by weight of the metal oxide particles, and more preferably from about 5-35% by weight. The metal oxide particles which are dispersed in the slurry are then pulverized thereby effectively reducing the average metal oxide particle size to a desired level, preferably less than about 5 microns, more preferably less than about 1 micron. Preferably, the pulverization step is carried out by a milling process, however, any suitable process or apparatus for effectively reducing the particle size of the metal oxide dispersed in the slurry is acceptable. Following the pulverization step, the slurry is mixed with a quantity of surfactant thereby forming the dispersion. Preferably, the mixing step is of a sufficient time to contact the metal oxide particles with the surfactant and suspend the metal oxide particles in the dispersion. In particularly preferred embodiments, an additional quantity of carrier is added to the slurry prior the surfactant addition step. The addition of extra carrier can assist in reducing the viscosity of the surfactant, thereby making the final mixture easier to handle. Generally, the amount of additional carrier is at least equal to the amount of surfactant.

In a further embodiment, a quantity of metal oxide particles which are already of the desired size for forming the dispersion are provided. In this embodiment, because the particles are already of the desired size, no pulverization step is required. The metal oxide particles are then mixed with respective quantities of surfactant and carrier for a sufficient time so that the metal oxide particles remain suspended in the dispersion for at least about one month.

In yet another embodiment of the invention, a quantity of metal oxide particles are provided and undergo a pulverizing step to reduce the size of the particles to a desired level. Preferably, the pulverizing step comprises passing the metal oxide particles through a mill. However, as noted above, any process or apparatus capable of producing the desired particle sizes may be used. The pulverized metal oxide particles are then mixed with respective quantities of surfactant and carrier to produce the dispersion, wherein the metal oxide particles remain suspended for at least about one month.

Preferred metal oxide particles for use with the present invention are selected from the group consisting of MgO, CaO, TiO₂, Fe₂O₃, SrO, BaO, and combinations thereof, with MgO being most preferred.

Any surfactant capable of suspending the metal oxide particles in the liquid carrier may be used, however, preferred surfactants are selected from the group consisting of saturated and unsaturated fatty acids, aliphatic and aromatic sulfonic acids, and combinations thereof. Oleic acid and dodecylbenzene sulfonic acid are particularly preferred surfactants for use in the present invention. If oleic acid is selected as the surfactant, the weight ratio of oleic acid to metal oxide is preferably at least about 50:1. If dodecylbenzene sulfonic acid is selected as the surfactant, the weight ratio of dodecylbenzene sulfonic acid to metal oxide is preferably at least about 14:1.

Carrier materials for use with the present invention can be mixtures of multiple components. Preferably, the carriers comprise some type of liquid fuel improver additive. Basically, any commercial or non-commercial fuel improver additive may be used within the scope of the present invention. Preferred fuel additives include those which comprise aliphatic and aromatic C₄-C₂₀ hydrocarbon compounds, glycol ethers, and esters.

Preferred metal oxide-containing dispersions according to the invention comprise from about 10-50% by weight of surfactant (more preferably from about 20-40%), from about 0.1-50% by weight of metal oxide (more preferably from about 5-35%), and from about 50-90% by weight of carrier (more preferably from about 60-80%).

Also included within the scope of the present invention are hydrocarbon fuels which comprise a quantity of a metal oxide-containing dispersion made in accordance with the present invention. The inventive dispersion, preferably in the form of a fuel improver additive, is added to the hydrocarbon fuel at a level sufficient to treat fuel contaminants. Preferred hydrocarbon fuels include but are not limited to gasoline, diesel, and kerosene.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The following example sets forth a preferred method of producing an improved dispersion having suspended therein a quantity of MgO. It is to be understood, however, that this example is provided by way of illustration and nothing therein should be taken as a limitation upon the overall scope of the invention.

Example

A slurry comprising 5.6% by weight MgO particles (having an average particle size of less than 1 micron, average crystallite size of approximately 8 nm, and a per unit weight surface area of about 230 m²/g) and the balance a fuel improver additive was milled for 20 minutes using 0.4 mm beads with an 80% fill, running at 5000 rpm, while the temperature was held constant at 72°F. After milling, the slurry had the characteristics of a thick, gray paste that was basically insoluble in the fuel improver additive. The surfactant oleic acid was added at a ratio of 50 parts by weight for each part MgO. An additional quantity of fuel improver was added to reduce the viscosity of the surfactant, thereby making the final slurry mixture easier to handle. The milled MgO slurry and surfactant were mixed using a high-speed mixer. Mixing continued for about 15 minutes until all of the MgO slurry became suspended. The final product was a transparent, light yellow-brown liquid comprising 56.7% by weight of the fuel improver additive, 42.4% by weight oleic acid, and 0.9% by weight MgO.

The oleic acid of the above example may be replaced with dodecylbenzene sulfonic acid at a ratio of 14 parts by weight per part MgO to yield a composition comprising 72.5% by weight of the fuel improver additive, 25.7% by weight dodecylbenzene sulfonic acid, and 1.8% by weight MgO.